

Amendments to the Claims

1. (Currently amended) A process for preparing ~~aromatic compounds~~ ferrocene, bisindenylferrocene or ruthenocene having a structural element of the formula I in the aromatic hydrocarbon ring,



where

M is -Li, -MgX₃, (C₁-C₁₈-alkyl)₃Sn-, -ZnX₃ or -B(O-C₁-C₄-alkyl)₂,

X₁ and X₂ are each, independently of one another, O or N and C-bonded hydrocarbon or heterohydrocarbon radicals are bound to the free bonds of the O or N atoms,

the group -C=C- together with carbon atoms forms a hydrocarbon aromatic and

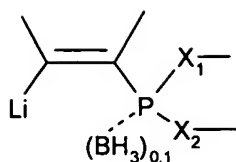
X₃ is Cl, Br or I,

characterized in that ~~an aromatic compound~~ ferrocene, bisindenylferrocene or ruthenocene having a structural element of the formula II in the aromatic ring,



where X₁ and X₂ are as defined above and the group -C=C- together with carbon atoms forms a hydrocarbon aromatic,

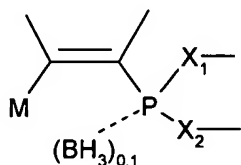
is reacted with at least equivalent amounts of alkyllithium, a magnesium Grignard compound or an aliphatic Li sec-amide or X₃Mg sec-amide, and, to prepare compounds of the formula I in which M is -MgX₃, (C₁-C₁₈-alkyl)₃Sn-, -ZnX₃ or -B(O-C₁-C₄-alkyl)₂, a lithium compound of the formula Ia,



(Ia),

is reacted with at least equivalent amounts of $\text{Mg}(\text{X}_3)_2$, $\text{Zn}(\text{X}_3)_2$, $(\text{C}_1\text{-C}_{18}\text{-alkyl})_3\text{SnX}_3$ or $\text{B}(\text{O-C}_1\text{-C}_4\text{-alkyl})_3$.

2. (Currently amended) ~~A compound~~ Ferrocene, bisindenylferrocene or ruthenocene having a structural element of the formula I in the aromatic hydrocarbon ring,

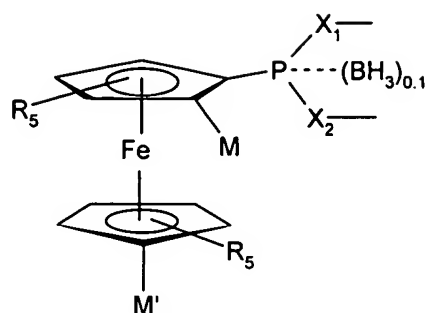


(I),

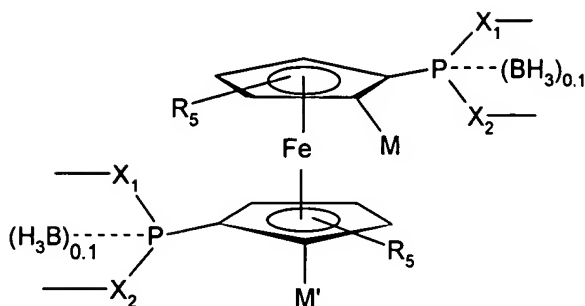
where

M, X_1 and X_2 are as defined in claim 1 and the group -C=C- together with carbon atoms forms a hydrocarbon aromatic.

3. (Currently amended) ~~The compound~~ Ferrocene, bisindenylferrocene or ruthenocene as claimed in claim 2, characterized in that they have ~~the compound of the formula I is a compound which has a ferrocene skeleton as aromatic compound and corresponds~~ correspond to the formula Ib or Ic,



(Ib),



(Ic),

where

R_5 is C_1 - C_4 -alkyl and preferably a hydrogen atom,

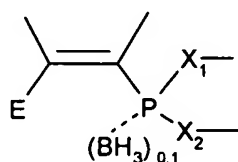
M is -MgCl, -MgBr and preferably Li,

M' is H, -MgCl, -MgBr or Li and

X_1 and X_2 and also the radicals bound to free bonds of X_1 and X_2 have the meanings given in claim 1 are each, independently of one another, O or N and C-bonded hydrocarbon or heterohydrocarbon radicals are bound to the free bonds of the O or N atoms.

4. (Cancelled)

5. (Currently amended) A process for preparing aromatic compounds- ferrocene, bisindenylferrocene or ruthenocene having a structural element of the formula III,



(III),

where

X_1 and X_2 and also the radicals bound to free bonds have the meanings given in claim 1 and E is the radical of a reactive, electrophilic compound which is able to replace a metal bound to hydrocarbon aromatics or a bound metal group, characterized in that a compound ferrocene, bisindenylferrocene or ruthenocene having a structural element of the formula I,



where

M, X_1 and X_2 and the radicals bound to free bonds have the meanings given in claim 1, is reacted with at least equivalent amounts of a reactive electrophilic compound.

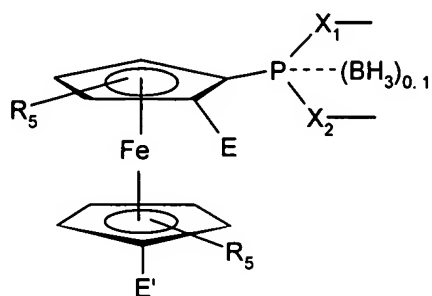
6. (Currently amended) A metallocene from the group consisting of ferrocene, bisindenylferrocene and ruthenocene having a structural element of the formula III in one or both cyclopentadienyl rings,



where

E is the radical of a reactive, electrophilic compound which is able to replace a metal bound to hydrocarbon aromatics or a bound metal group, X_1 and X_2 and hydrocarbon radicals bound to the free bonds of the groups X_1 and X_2 have the meanings given in ~~claims 1 and 5~~ claim 1.

7. (Original) The metallocene as claimed in claim 6, characterized in that it corresponds to the formula IV,

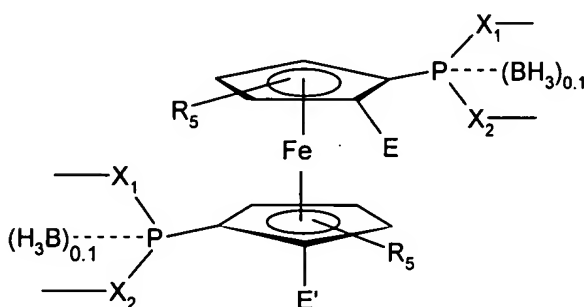


(IV),

where

R₅ is C₁-C₄-alkyl and preferably a hydrogen atom, E' is H or independently has one of the meanings of E, and E, X₁ and X₂ and hydrocarbon radicals bound to the free bonds of the groups X₁ and X₂ have the meanings given in claim 6.

8. (Original) The metallocene as claimed in claim 6, characterized in that it corresponds to the formula Iva,



(IVa),

where

E' is H or independently has one of the meanings of E,
R₅ is C₁-C₄-alkyl and preferably a hydrogen atom and
E, X₁ and X₂ and hydrocarbon radicals bound to the free bonds of the groups X₁ and X₂ have the meanings given in claim 6.

9. (Currently amended) A process for preparing ~~hydrocarbon-aromatic~~ ferrocene, bisindenylferrocene or ruthenocene diphosphines having structural elements of the formula VI in an aromatic hydrocarbon ring,



or having structural elements of the formula VIa in each cyclopentadienyl ring of a metallocene,



where

R₁₆ is a direct bond or a divalent bridging group, with the sec-phosphino in the bridging group being located in the 1, 2 or 3 position relative to the carbon atom of the aromatic ring, and

R₁₇ is a substituent which is bound via a carbon atom to the aromatic ring,

which comprises the steps:

a) reaction of ~~an aromatic compound~~ ferrocenes, bisindenylferrocenes or ruthenocenes having structural elements of the formula II



with metalation reagents to form ~~an aromatic compound~~ a ferrocene, bisindenylferrocene or ruthenocene having structural elements of the formula I



where M, X₁ and X₂ and hydrocarbon radicals bound to the free bonds of the groups X₁ and X₂ have the meanings given in claim 1,

b) reaction of ~~the compound~~ ferrocenes, bisindenylferrocenes or ruthenocenes having structural elements of the formula I with an electrophilic and reactive compound, wherein

b1) the compound of the formula I is reacted with a sec-phosphine halide to introduce sec-phosphino,

b2) the compound of the formula I is reacted with an electrophilic reactive compound which has a reactive group which can be replaced by sec-phosphino in the 1, 2 or 3 position and the product is subsequently reacted with a metal sec-phosphate or a secondary phosphine to introduce the group -R₁₆-sec-phosphino,

b3) the compound of the formula I is ~~reacted~~ with an electrophilic organic compound which forms an α-carbon atom to introduce the group -R₁₇,

c) any borane group present is removed from the compounds obtained in steps b1), b2) or

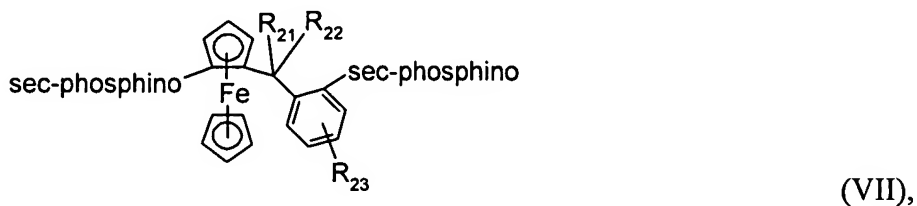
b3) and the radicals (hetero)hydrocarbon-X₁, (hetero)hydrocarbon-X₂ or X₁-

(hetero)hydrocarbon-X₂ are subsequently split off to form a -PCl₂ group or -PBr₂ group and the Cl or Br atoms are then replaced by a hydrocarbon radical by means of an organometallic compound to form the sec-phosphino group, or

d) the radicals (hetero)hydrocarbon-X₁, (hetero)hydrocarbon-X₂ or X₁-

(hetero)hydrocarbon-X₂ are split off to form a -PCl₂ group or -PBr₂ group and the Cl or Br atoms are then replaced by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group and the borane group is then removed.

10. (Currently amended) ~~The A process as claimed in claim 9~~ for preparing 1-(α -substituted ortho-sec-phosphinobenzyl)-2-sec-phosphinoferrocenes of the formula VII in the form of their racemates, mixtures of diastereomers or essentially pure diastereomers,



where

R₂₁ is hydrogen, C₁-C₆-alkyl, C₃-C₈-cycloalkyl, unsubstituted or F-, C₁-C₆-alkyl- or C₁-C₆-alkoxy-substituted phenyl or benzyl,

R₂₂ is C₁-C₄-alkoxy, C₁-C₈-acyloxy or sec-amino and

R₂₃ is hydrogen, C₁-C₄-alkyl or C₁-C₄-alkoxy,

which comprises the steps:

a) reaction of a compound of the formula VIII

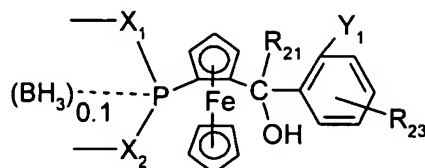


where

M and the group -P(X₁)(X₂)-(BH₃)_{0.1} are as defined in claim 1, with a compound of the formula IX



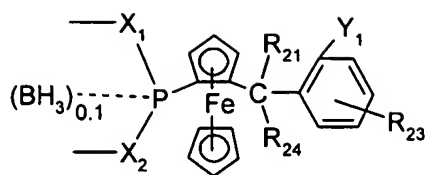
where Y_1 is Cl, Br or I and R_{23} and R_{21} are as defined in claim 1, to form a compound of the formula X,



(X),

- b) C_1 - C_4 -alkylation or C_1 - C_8 -acylation of the OH group in the compound of the formula X or replacement of the acyloxy group formed by sec-amino,
- c) replacement of the halogen Y_1 in compounds of the formula X by sec-phosphino and subsequent conversion of the group $-P(X_1-)(X_2-)---(BH_3)_{0.1}$ into a sec-phosphino group, or conversion of the group $-P(X_1-)(X_2-)---(BH_3)_{0.1}$ firstly into a sec-phosphino group and subsequent replacement of the halogen Y_1 in compounds of the formula X by sec-phosphino,
- d) preparation of the diphosphine of the formula VII, by
- d1) removing any borane group present from a compound of the formula X, then splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group, or
- ~~e2)~~ d2) splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group and then removing the borane group.

11. (Currently amended) A compound of the formula XI in the form of a racemate, diastereomer or pair of diastereomers,

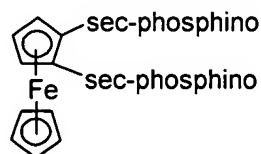


(XI),

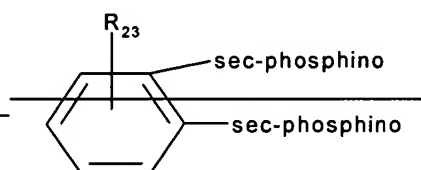
where

~~the group~~ $P(X_1)(X_2)---(BH_3)_{0.1}$, X_1 and X_2 are each, independently of one another, O or N and C-bonded hydrocarbon or heterohydrocarbon radicals are bound to the free bonds of the O or N atoms, R_{21} , R_{23} and Y_1 are as defined in ~~claims 1 and 10~~ claim 10, or (X_1-) and (X_2-) in the group $-P(X_1-)(X_2-)--(BH_3)_{0.1}$ are Cl or Br, and R_{24} is -OH, C₁-C₄-alkoxy, C₁-C₈-acyloxy or sec-amino.

12. (Currently amended) ~~The A process as claimed in claim 9 for preparing compounds of the formula XII in the form of racemates, diastereomers and pairs of diastereomers and also compounds of the formula XIII,~~



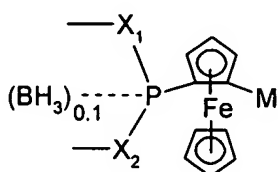
(XII),



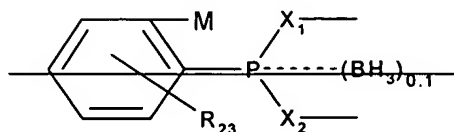
~~(XIII),~~

which comprises the steps

a) reaction of a compound of the formula XIV or XV



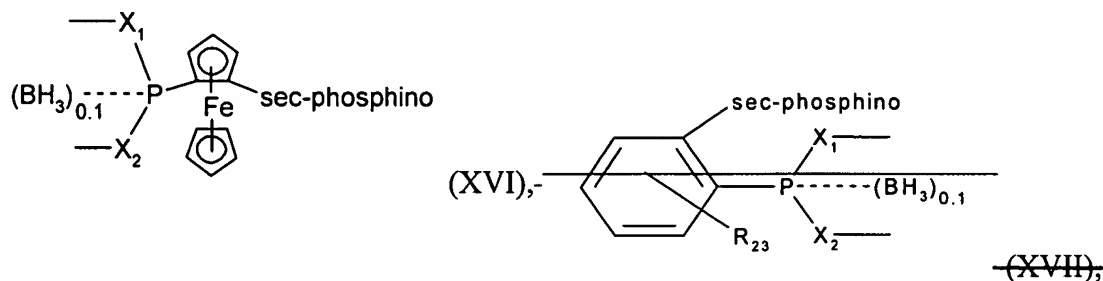
(XIV),



~~(XV),~~

where

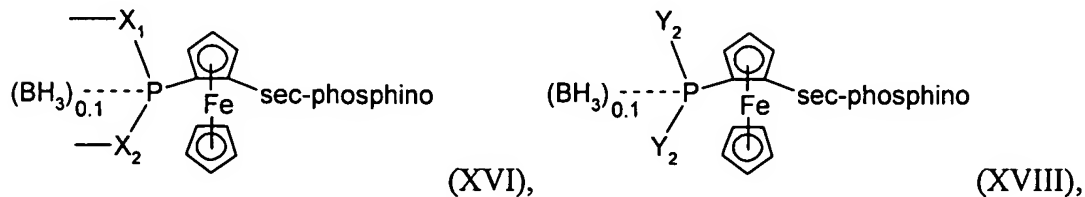
M, R_{23} and the group $-P(X_1)(X_2)---(BH_3)_{0.1}$ are as defined in ~~claims 1 and 10~~ claim 1, with a sec-phosphine halide (chloride or bromide) to produce compounds of the formula XVI or XVII,



b) preparation of diphosphines of the formulae XII and XIII by

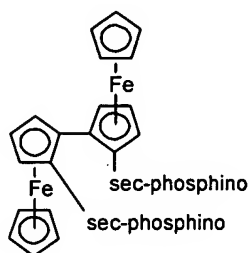
- b1) removing any borane group present from a compound of the formula XVI or XVII, then splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group, or
- b2) splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group and then removing the borane group.

13. (Original) A compound of the formula XVI or XVIII in the form of a racemate, diastereomer or pair of diastereomers,



where the group $-P(X_1)(X_2)---(BH_3)_{0.1}$ is as defined in claim 1 and Y_2 is Cl or Br.

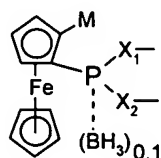
14. (Currently amended) The A process as ~~claimed in claim 9~~ for preparing compounds of the formula XIX in the form of racemates, diastereomers and pairs of diastereomers,



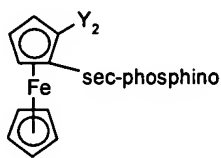
(XIX),

which comprises the steps

a) reaction of a compound of the formula XX with a compound of the formula XXI,



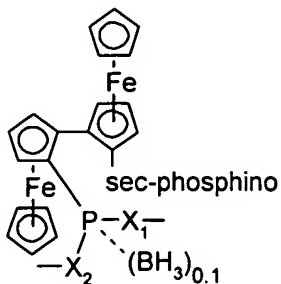
(XX),



(XXI),

where

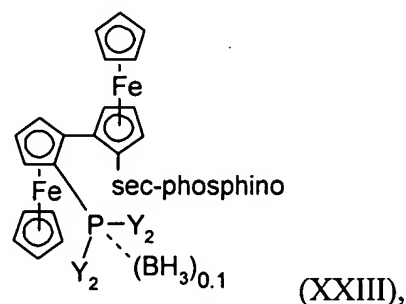
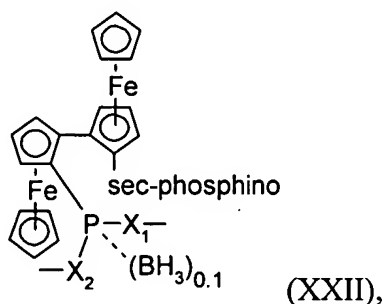
M is $-\text{Sn}(\text{C}_1\text{-C}_4\text{-alkyl})_3$ or $-\text{ZnX}_3$, the group $-\text{P}(\text{X}_1-)(\text{X}_2-)\text{---}(\text{BH}_3)_{0.1}$ is as defined in claim 1 and Y_2 is I or Br, in the presence of a Pd catalyst to form a compound of the formula XXII



(XXII),

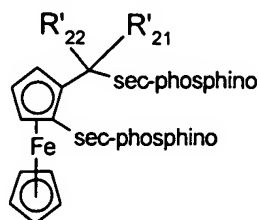
- b) preparation of diphosphines of the formula XIX by
- b1) removing any borane group present from a compound of the formula XXII, then splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)-hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group, or
- b2) splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group and then removing the borane group.

15. (Original) A compound of the formula XXII or XXIII in the form of a racemate, diastereomer or pair of diastereomers,



where the group $-P(X_1)(X_2)---(BH_3)_{0.1}$ is as defined in claim 1 and Y_2 is Cl or Br.

16. (Original) The process as claimed in claim 9 for preparing compounds of the formula XXIV in the form of racemates, diastereomers and pairs of diastereomers,



(XXIV),

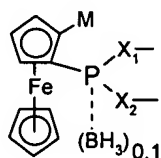
where

R'_{21} is hydrogen or C_1 - C_6 -alkyl,

R'_{22} is C_1 - C_6 -alkyl, C_3 - C_8 -cycloalkyl, unsubstituted or F-, C_1 - C_6 -alkyl- or C_1 - C_6 -alkoxy-substituted phenyl or benzyl,

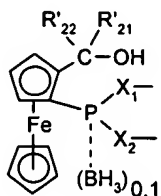
which comprises the steps

a) reaction of a compound of the formula XX,



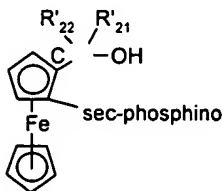
(XX),

with an aldehyde or ketone of the formula $R'_{21}R'_{22}C(O)$ to form a compound of the formula XXV,



(XXV),

b) preparation of compounds of the formula XXVI,



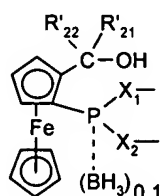
(XXVI),

by

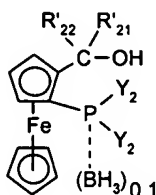
b1) removing any borane group present from a compound of the formula XXV, then splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)-

hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group, or
 b2) splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group and then removing the borane group,
 c) acylating the compound of the formula XXVI, for example by means of a carboxylic anhydride, and
 d) replacing the C_1 - C_8 -acyloxy group formed by means of a secondary phosphine to give compounds of the formula XXIV.

17. (Currently amended) A compound of the formula XXVII or XXVIII in the form of a racemate, diastereomer or pair of diastereomers,



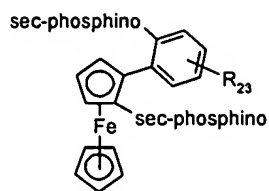
(XXVII),



(XXVIII),

where R_{21} and R_{22} are as defined in claim 16, Y_2 is Cl or Br and the group $-P(X_1)(X_2)-$ $-(BH_3)_{0.1}$ is as defined in claim 1 X_1 and X_2 are each, independently of one another, O or N and C-bonded hydrocarbon or heterohydrocarbon radicals are bound to the free bonds of the O or N atoms.

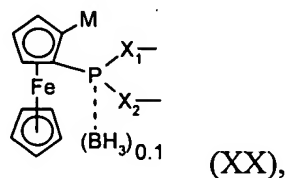
18. (Currently amended) The process as claimed in claim 9 for preparing compounds of the formula XXIX in the form of racemates, diastereomers and pairs of diastereomers,



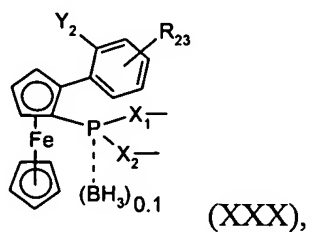
(XXIX),

which comprises the steps

a) reaction of a compound of the formula XX

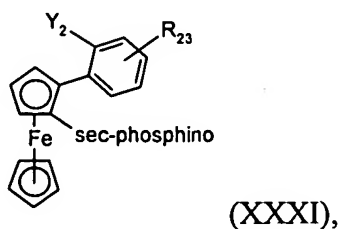


where M is $-\text{Sn}(\text{C}_1\text{-C}_4\text{-alkyl})_3$ or $-\text{ZnX}_3$, ~~the group $\text{P}(\text{X}_1-)(\text{X}_2-)(\text{BH}_3)_{0.1}$ is as defined in claim 1~~ X_1 and X_2 are each, independently of one another, O or N and C-bonded hydrocarbon or heterohydrocarbon radicals are bound to the free bonds of the O or N atoms, with 1-bromo-2-iodobenzene or 1,2-diiodobenzene in the presence of a Pd catalyst to form a compound of the formula XXX,

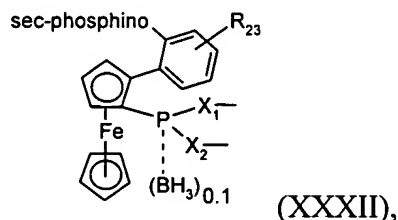


where Y_2 is bromine or iodine,

b) to prepare monophosphines of the formula XXXI



- b1) removing any borane group present from a compound of the formula XXX, then splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)-hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group, or
- b2) splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group and then removing the borane group, and
- c) then replacing the bromine or iodine atom by a sec-phosphino group by metalation by means of a lithium alkyl (butyllithium) and subsequent reaction with a sec-phosphine halide, or
- d) to prepare compounds of the formula XXXII

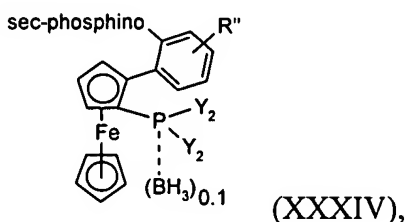
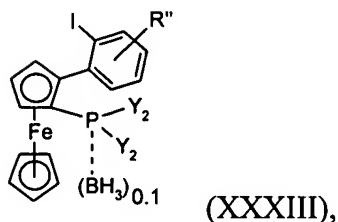
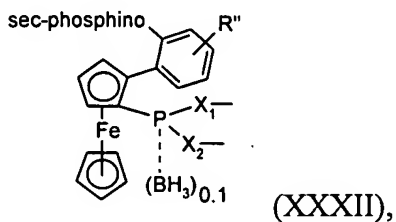
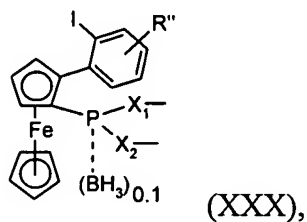


reacting a compound of the formula XX with ortho-sec-phosphinophenyl iodide in the presence of metal halides such as $ZnBr_2$ and Pd catalysts, and

- d1) removing any borane group present from a compound of the formula XXXII, then splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)-hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group, or
- d2) splitting off the radicals (hetero)hydrocarbon- X_1 , (hetero)hydrocarbon- X_2 or X_1 -(hetero)hydrocarbon- X_2 to form a $-PCl_2$ group or $-PBr_2$ group and then replacing the Cl

or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group and then removing the borane group.

19. (Original) A compound of the formula XXX, XXXII, XXXIII or XXXIV in the form of a racemate, diastereomer or pair of diastereomers,



where the group $-P(X_1)(X_2)---(BH_3)_{0.1}$ is as defined in claim 1, Y_2 is Cl or Br and R'' is hydrogen or a substituent.

20. (Currently amended) The process as claimed in claim 9 for preparing compounds of the formula XXXV in the form of racemates, diastereomers and pairs of diastereomers,



where

R_{24} is a radical of the formula $-CR_{25}R_{26}-Y_3$ or a group R_{28} ,

R₂₅ is hydrogen, C₁-C₆-alkyl, C₃-C₈-cycloalkyl, unsubstituted or F-, C₁-C₆-alkyl- or C₁-C₆-alkoxy-substituted phenyl or benzyl,

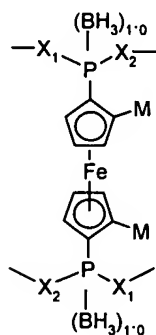
R₂₆ is C₁-C₆-alkyl, C₃-C₈-cycloalkyl, unsubstituted or F-, C₁-C₆-alkyl- or C₁-C₆-alkoxy-substituted phenyl or benzyl,

Y₃ is C₁-C₄-alkoxy, C₁-C₈-acyloxy or sec-amino and

R₂₈ is C₁-C₆-alkyl, C₃-C₈-cycloalkyl, unsubstituted or F-, C₁-C₆-alkyl- or C₁-C₆-alkoxy-substituted phenyl or benzyl,

which comprises the steps

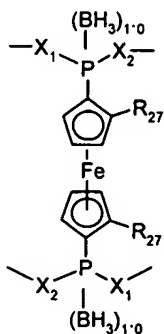
a) reaction of a compound of the formula XXXVI



(XXXVI)

where

the group $\text{P}(\text{X}_1)(\text{X}_2) - (\text{BH}_3)_{0.1}$ is as defined in claim 1 X₁ and X₂ are each, independently of one another, O or N and C-bonded hydrocarbon or heterohydrocarbon radicals are bound to the free bonds of the O or N atoms, with an aldehyde or ketone or imine of the formula CR₂₅R₂₆=Y₄, where Y₄ is =O or =N(C₁-C₄-alkyl), or with a halide R₂₈Y₆, where Y₆ is Cl, Br or iodine, to form compounds of the formula XXXVII



(XXXVII),

where

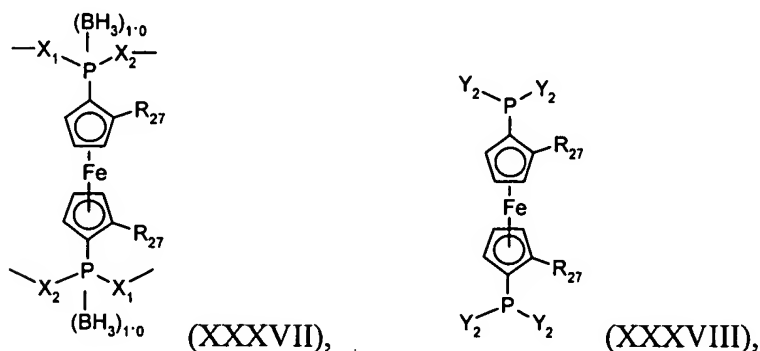
R₂₇ is the group -CR₂₅R₂₆-Y₅ or R₂₈, where R₂₅ and R₂₆ are as defined above and Y₅ is -OH or -NH(C₁-C₄-alkyl), alkylating the NH group, if appropriate alkylating or acylating the OH group and, if appropriate, replacing the acyloxy group by sec-amino and

b) to prepare compounds of the formula XXXV

b1) removing any borane group present from a compound of the formula XXXVII, then splitting off the radicals (hetero)hydrocarbon-X₁, (hetero)hydrocarbon-X₂ or X₁-(hetero)-hydrocarbon-X₂ to form a -PCl₂ group or -PBr₂ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group, or

b2) splitting off the radicals (hetero)hydrocarbon-X₁, (hetero)hydrocarbon-X₂ or X₁-(hetero)hydrocarbon-X₂ to form a -PCl₂ group or -PBr₂ group and then replacing the Cl or Br atoms by a hydrocarbon radical by means of an organometallic compound (Grignard reagent) to form the sec-phosphino group and then removing the borane group.

21. (Currently amended) An intermediate in the form of a racemate, diastereomer or pair of diastereomers, ~~in particular an intermediate of the formula XXXVII or XXXVIII,~~



where

~~R₂₇ and Y₂ are~~ is as defined in claim 1 and the group P(X₁)(X₂)-(BH₃)_{0.4} is as defined in claim 1 20. X₁ and X₂ are each, independently of one another, O or N and C-bonded hydrocarbon or heterohydrocarbon radicals are bound to the free bonds of the O or N atoms, and Y₂ is Cl or Br.